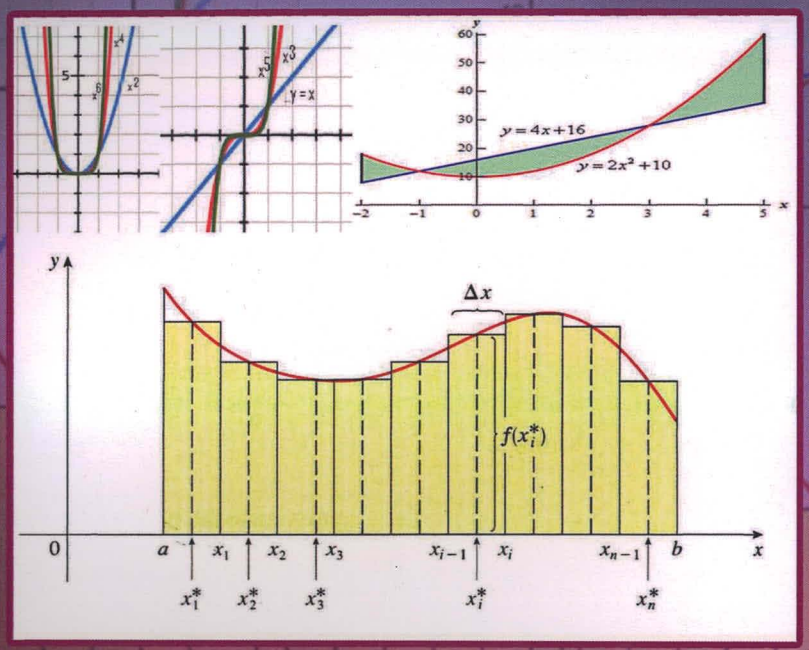
# CALCULUS WITH SINGLE VARIABLE

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# CHAPTER 3

## APPLICATIONS OF DIFFERENTIATION

Zaharah Wahid

The derivative of a function has many applications to problems in calculus. It may be used in curve sketching; solving maximum and minimum problems; solving distance; velocity, and acceleration problems; solving related rate problems; and approximating function values. After completing chapter 1 and 2 you should be able to solve many differential problems in engineering. Exercises included in this chapter cover a wide variety of daily events to show the relevance of calculus to students' majors.

At this point it is interesting to note how Islam has contributed to civilization. The two remarkable and renowned Muslim mathematicians by the name Muhammad Al-Karaji and Abu Abdullah Muhammad bin Musa Al-khwarizmi. They had introduced the theory of Algebraic Calculus. The adoption of the sign of zero had led to the so called "Arithmetic of positions". Also with the help of the Arab system of numbers, elementary methods of calculations were perfected.

In differential calculus we shall discuss the first and second derivatives of a function. However our focus here is on a function of one variable.

### 3.1 Linear Approximations and Newton's Method

#### 3.1.1 Small Changes and Linear Approximations

The derivative of a function can be used to approximate certain function values with high degree of accuracy. The concept of the differential of the independent variable and the dependent variable will be discussed.

The definition of the derivative of a function $y = f(x)$ is

$$f'(x) = \lim_{\Delta x \to 0} \frac{f(x_1 + \Delta x) - f(x)}{\Delta x}$$

which represents the slope of the tangent line to the curve at a point $(x, f(x))$ is also called the slope of the curve. If $\Delta x$ is very small ($\Delta x \neq 0$), then the slope of the tangent line is